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RICE IN MALAYA.

By

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(Continued.)

V. Harvesting, Threshing and Winnowing.

Harvesting and Threshing :—

On account of the variations in the seasons in different localities, harvesting operations are generally in progress in some portion of Malaya between the beginning of November and the end of April.

Primitive methods of reaping are practised, machine reapers having only been used experimentally so far. Two-thirds of the Malayan crop, whatever method of cultivation is employed, is cut by women using the "pisau menuai" a peculiar knife set in a wooden base to fit the palm of the hand. This strange knife cuts each ear of padi separately and the straw, having no monetary value, is left standing in the rice fields. The ears of padi so cut are bound together in bunches and usually sun-dried before being threshed. The Malay women are highly skilled in the use of this knife and the rapidity of their work may be gauged by the fact that one woman can cut 80 to 90 "gantangs" of unthreshed padi per day of 7 hours which is equivalent to 40 "gantangs" of clean (threshed and winnowed) padi.

The rate at which Malay women work depends on their own industry and the condition of the crop (erect or lodged). The density of crop appears to make no material difference to the rate of harvesting (i).

When the crop is cut in this way it is threshed by precipitating the bunches of padi ears on to sheets of grass-matting in the field or at the cultivator's dwelling or on to clean baked soil and by treading on them turning them over repeatedly with the feet in a rolling motion, when the resulting friction separates the grain from the ear. Frequently Tamils beat the padi with sticks instead of using their

feet. This method involves more energy but saves the worker's feet. A good Malay can thresh and winnow 80 to 100 gantangs of clean padi per day, though sore feet would prevent him from doing it on several successive days. The use of sticks in threshing by Tamils, though somewhat slower than the use of the feet, can be continued for a longer spell and consequently an equal amount of clean padi per day can be prepared by either method.

The ear stalks and large pieces of straw are separated by hand from the grain which is later cleaned of all chaff, dust or other valueless matter by winnowing processes. Tamils sometimes cut their padi with the "pisau menuai" also, though they prefer to use a simple knife and work less rapidly on the average than a good Malay. Tamil women can cut about 3 sacks of ears, that is about 35 gantangs clean padi, in a day of 8 hours.

In the northern rice districts near the West coast, where Indian immigrant coolies have long been employed, at first on sugar and now on rubber estates, the bulk of the crops is reaped by Tamil contract labour paid in kind, that is, in gantangs of padi. The contract rate varies between 12% and 25% of the cleaned unhusked crop according to its density and its condition at harvest, an average being 15% under good conditions.

The grain together with about 2 feet of straw is cut in armfuls with a short sharp saw-edged sickle ("sabit") the armfuls being laid on the top of the stubble, which is one to two feet high, to dry. The bunches are loosely bound with straw into sheaves which are conveyed singly to the threshing "tong," which simply consists of a large wide tub. Against the inside of the tub and at inclination to its side a ladder with rounds about 4 inches apart is placed and the sheaves are beaten two or three times on this ladder, the shock of the blow causing the grains of padi to drop into the tub, while all scattered grains are directed back to the tub by a conveniently placed screen of "menkuang" (*Pandanus* sp.) matting. Tamil contract includes the winnowing and drying of the grain. Tamils usually work in parties of five or more. A good party can cut and thresh a heavy crop, at the rate of ¾ of an acre per man per day of eight hours.

Frequently it becomes necessary to harvest the crop in rainy weather. In very wet seasons the soil is often covered by 3—12 inches of water or more at the time of reaping. Under these conditions the work of harvesting is greatly retarded because the movements of the reapers are slower by reason of the stickiness of the mud, and varying amounts of the padi may be lodged or submerged thus rendering the cutting operation more laborious than usual. Moreover the ripe heads of padi frequently hang down into the water and thus germination, quickly followed by decay, causes a considerable loss in the crop. Apart from these reasons much ripe grain falls from the ears in handling the padi straw which often becomes flacid and makes handling well nigh impossible besides forcing the reaper to cut his crop ear by ear. In addition to these difficulties showery weather prevents the threshed padi from drying with the result that germination of the grain sets in and heavy losses are sustained, The total loss of

crop in a wet harvest may amount to as much as half the crop anticipated prior to the damage caused by heavy rains and flood.

Threshing can be carried on independently of the weather, in fact, the Tamils like a few showers since the grains appear to become more easily detached from the straw in damp weather, and the Malays who tresh with their feet, maintain that the work is less injurious to the feet if the bunches of padi are wet. Whatever the effects of rain may be on threshing, it is certainly more desirable that there should be dry weather during harvest for all other operations. Dry weather is particularly required if the grain is to be rapidly and thoroughly dried for should drying be prolonged the grain rapidly deteriorates in quality and value.

Winnowing :

After threshing, which operation comprises the hand separation of the straw from grain, the padi when thoroughly dried is winnowed to remove the smaller pieces of broken straw, empty husks, dust etc. The methods of winnowing are simple, but considering the small size of the holdings they are economical and very efficient, In the northern parts of the country, the fairly strong and constant breeze which usually prevails at harvest time from 11 a.m. to 5 p.m. daily is advantageously used to separate the good from the defective and the chaff grain. A deep circular tray-shaped basket about 3 feet in diameter and of open half inch mesh is suspended from the point of contact of three stout bamboes forming a triped some six feet high. The uncleaned padi is placed on this basket-sieve which is then rocked gently from side to side so that the padi falls through it in a slow steady stream. The wind carries the chaff, dust, straw etc. beyond the matting which is placed below the tripod to receive the good heavy clean grain. The good padi, thus separated from the chaff, is subjected to a further and final separation and cleaning by repeating the process just described and is then measured into sacks ready for purchase by the millers.

In place of using a basket-sieve suspended from a tripod, frequently, a shallow bottomed basket ("niru") tapering at one end and having a rim about an inch high is filled with padi and held aloft in the hands or on the head at an inclination so that the padi runs off slowly and the breeze effects the required separation of good grain from empty husk, dust, etc. Sometimes this basket has a sieve-bottom, which allows dust to pass through but retains the padi grain. The basket is grasped in both hands about waist high, and with a series of smart jerks, the padi is thrown one to two feet upwards, and the wind carries away the chaff and dust, while the good grain falls back to the basket. Very occasionally when the wind is strong a flat wooden shovel is used for winnowing purposes the padi merely being hurled through the breeze from one position to another.

A further method of winnowing with the "niru" depends on dexterity and experience in manœuvring the empty grains, chaff, etc. by gravitation to the tapered end of the "niru" and then ejecting it with

a sharp wrist movement. Women (Malays and Tamils) are exceedingly expert in this method, very little good grain being lost for the finished clean grain rarely contains more than 1% of debris. The padi hand-winnowing machine affords much the quickest native method of winnowing when the crop is perfectly dry. This very efficient machine is said to have been introduced by the Chinese through Siam. In essential it consists of a box in which a fan is rotated by hand to create the necessary draught for separating the grain. The box opens at one end into a passage through which the breeze escapes. The padi to be winnowed is contained in a hopper placed above this passage and stream of padi from the hopper is easily regulated by adjusting a wooden slat. The padi runs through the artificial breeze and is directed into a sack or basket. The chaff, however, is blown through the escape passage and discarded. Two coolies working this machine can winnow 200 gantangs of padi per hour.

1. Harvesting Padi and its conversion into Rice—H. W. Jack—Agr. Bull. F.M.S., Vol. VIII, No. 1., 1920.

VI. CROPS.

Padi crops vary somewhat from season to season, the chief cause of variation being the amount of rainfall and more particularly its distribution. Thus in the Krian district the annual crops which averaged 14,089,590 gantangs of clean unhusked rice for the twelve years 1910 to 1922, varied in quantity as shown below:—

Season.	Yield.	Season.	Yield.
1910-1911	15,292,899	1916-1917	13,602,662
1911-1912	11,211,168	1917-1918	14,948,072
1912-1913	14,698,320	1918-1919	11,340,352
1913-1914	15,130,601	1919-1920	16,083,702
1914-1915	15,646,611	1920-1921	11,158,259
1915-1916	16,056,289	1921-1922	13,906,130

The fluctuation in seasonal yield only refers to variation within a clearly defined area but the variation in yield between different districts in the same season is much more marked. Thus the best yielding wet padi district (Penang) in a good season has been known to produce at the rate of nearly 470 gantangs per acre over an area of 5,000 acres. On areas of about 5,000 acres this yield is approached in the "mukims" of Bagan Tiang, Kuala Kurau, Parit Buntar and Tanjong Piandang in good seasons, but few other areas of this size or larger can produce over 350 gantangs per acre, for instance the yield per acre in Kuala Pilah which is considered a good padi district is only 240 gantangs of padi in a good season.

There are many smaller areas up to 1,000 acres in extent which produce between 250 and 350 gantangs of padi per acre annually, for example, the mukims of Grik, Lenggong, Ulu Jempol, Serting Hilir, Triang Hilir, Slim, Pulau Tiga, Beranang etc., but numerous smaller areas only produce between 80 and 200 gantangs per acre. These great differences in yield may be due to soil variations, to lack of application on the part of the cultivator, to irrigation difficulties, to scarcity of buffaloes, to epidemic disease amongst cultivators, to the ravages of pests, to bad seeds etc., but they combine to show that there is much room for improvement when the average yield for the whole country (wet and dry padi) is only 192 gantangs of clean unhusked rice (1020 lbs.) per acre per annum. Small areas, as a rule, show a low average of production because they are more severely damaged by animal pests. Dry padi crops are mostly derived from small, more or less isolated patches of land, frequently bordered by jungle and consequently pests, particularly pigs, birds and rats destroy a fairly large proportion of each crop, so that yields rarely show as good an an average as in the case of padi. Also dry padi crops are very dependent on rainfall and therefore crops are precarious. Moreover as mentioned in Chapter IV continuous cropping of the same land, tends to reduce successive yields considerably.

Table VI shows the total production of padi (wet and dry) in each State, the rate of production per acre of wet and dry padi and the average yield per head of population.

TABLE VII.

State or Province.	Average area under rice.	Average yield per annum in gantangs.	Average yield per acre in gantangs.		Average yield per head of population in gantangs.
			WET	DRY	
Kedah	174,000	44,001,000	253	165	130
Perlis	31,000	5,340,000	192	162	133
P. Wellesley	33,500	9,310,000	282	151	72
Penang town	—	—	—	—	—
,, country	6,030	2,261,730	370	—	58
Dindings	720	84,000	135	102	7
Perak	119,505	21,173,500	241	121	35
Krian district	55,000	13,869,000	267	90	161
Selangor (K. L. town)	—	—	—	—	—
,, country	18,410	1,424,000	145	57	4.5
Negri Sembilan	30,400	4,602,000	160	187	25
Pahang	30,025	4,223,000	163	104	29
Malacca town	—	—	—	—	—
,, country	27,622	7,712,000	246	—	63
Singapore	—	—	—	—	—
Trengganu	10,800	2,000,000	200	151	130
Kelantan	175,050	32,436,050	193	162	105
Johore	13,200	1,424,000	160	76	5
Total Malaya	669,262	13,991,280	203	110	41

The figures under the second and third columns in table 6 are based in every case on not less than three years' results and in the case of the Federated Malay States the averages are worked out from figures extending over ten years.

As regards Kedah and Perlis the average yields per annum are based on only three seasons' results. One of these seasons, 1920-21, was bad beyond all precedent from the rainfall point of view with the result that large areas were not planted at all and in other areas the crop was not deemed worth harvesting. Probably the normal production of Kedah averages around sixty million gantangs whereas in the table above it is shown as forty-four millions only. Kedah is the largest producing State though the average area under cultivation is slightly less than in Kelantan.

Next to Kedah, Kelantan is the largest producer, though the production per acre is much lower than in the case of Kedah, probably partly due to the vagaries of the rivers for most of the rice fields in Kelantan are situated along the banks of the main river, whereas in Kedah most of the padi fields are part of the enormous flat stretches of coastal land and are not so subject to rapid changes in the water table. Also, the more scattered distribution of padi land in Kelantan would tend to expose the crop more to animal pests, than in Kedah where padi areas are more concentrated. Perak, Province Wellesley

and Malacca are the next largest producing states in order of their production, but owing to the large influx of immigrant labourers the amount of padi produced per head of population is insufficient and large imports of rice are necessary each year. Kedah, Perlis, Kelantan and Trengganu States and the Krian district of Perak are the only areas which can be classed as self-supporting. In each of these areas Malay is the predominant element of the population and immigrant labourers are comparatively few in number.

Perlis, Kelantan and Trengganu are little known States and are still undeveloped compared with the Federated Malay States and therefore have not been opened up by industrial pioneers and their complements of immigrant coolies. Kedah, some years ago was a fairly large exporter of padi but the great progress of the rubber industry in the south of the State and the development of transport facilities in the last seven or eight years have drawn capital and hordes of immigrant coolies who now consume practically all the padi produced in that State except in bumper years when there is a small export. The Krian district of Perak is, agriculturally probably the most thriving district in Malaya. It maintains a large Malay population and in addition supports a numerous body of Indian labourers for the District contains some 61940 acres of rubber and coconut estates, but the high production of padi per head of population is entirely due to the irrigation system which the Government maintains for the welfare of the cultivators. Of all padi producing states, Selangor which shows the smallest production per head of population, contains by far the largest number of immigrant coolies in proportion to its area, because it has been the centre of the rubber industry and the seat of Government. Nevertheless, the area under padi cultivation is very small, partly because little good padi land is accessible but also because the Malay population is scattered and has turned to rubber cultivation at the expense of the padi industry.

The District of Kuala Selangor, however, possesses possibilities of enormous development from the point of view of rice production, if only the right type of cultivator can be induced to settle there.

TABLE VIII.

Dry Padi Areas in Malaya.

State or Province.	Area (acres).	Yield in gantangs.	Yield per acre in gantangs.
Perak ...	20,840	2,521,960	121
Selangor ...	3,276	220,774	67
Negri Sembilan ...	422	36,726	87
Pahang ...	5,222	542,293	104
Perlis ...	65	10,500	162
Johore ...	4,567	347,842	76
Kedah ...	3,570	588,081	165
Kelantan ...	250	37,950	162
Trengganu ...	3,303	500,000	151
Province Wellesley ...	1,000	150,813	151
Dindings ...	615	62,266	102
Total Malaya ...	43,130	5,019,205	146

In the above table the figures for the Federated Malay States have been averaged from statistics covering eight years but in all other States the figures represent the averages of three years only. The table discloses the fact that Perak produces approximately 50% of the total amount of dry padi in Malaya. This is probably due to the large number of small villages dotted about Perak and indicates an attempt at self support by villagers to whom wet padi land is not available, for dry padi, as a rule, is only planted where wet padi land is unobtainable or where very fertile new soil can be planted on the hill sides. The large number of "sakai" clearings, doubtless, is also a factor in dry padi production in Perak.

Of the Federated Malay States, Lower Perak district is by far the largest producer of dry padi, its annual average production being 1,025,600 gantangs, though the amount of padi grown on estates in the district in 1917 and 1918 was a considerable factor towards attaining this average. Moreover the padi returns hardly differentiate wet and dry padi with sufficient clearness but still making allowances the district easily holds first place from the point of view of production. Batang Padang and Upper Perak come next in order of production with averages of 406,000 and 342,900 gantangs respectively per annum.

In each of the three districts above mentioned the increase of Malay population has been very rapid in the last decade and these increases greatly stimulated dry padi production. Thus Batang Padang district which shows an increase of 52% in the Malay population in the last decade shows an increase of over 200% in dry padi production in the same period. Unfortunately, in this district the amount of wet padi land put under cultivation shows no appreciable change during the same decade because suitable land is not available, hence the Malays are driven to the less profitable alternative of dry padi production. Similar though less pronounced increases in Malay population and dry padi production are recorded in the districts of Lower and Upper Perak. Kinta and Kuala Lipis are the next largest producers with averages of 317,000 and 314,800 gantangs respectively, with Kuala Kangsar taking sixth place with 214,000 gantangs annually. Larut with an annual average production of 146,000 gantangs, and Pekan with 104,000 gantangs are the only other districts in the Federated Malay States which produce over 100,000 gantangs annually. Kedah, Trengganu and Johore show fairly large annual productions, but the areas fromwhich these are derived are small and scattered. Of these states the Padang Terap district of Kedah is the largest producer with about 100,000 gantangs per annum.

Table IX. shows the chief dry rice producing districts and the variation in area in acres in each year for seven years.

TABLE III.

Area under dry padi in acres—Seasons 1915-1922.

	Upper Perak.	Larut and Matang.	Kuala Kangsar.	Kinta.	Batang Padang.	Lower Perak.	Kuala Selangor.	Ulu Selangor.	Kuala Lipis.	Pekan.	Padang Trap.	Muar.
1915-16	512	298	370	1152	776	3220	3822	650	2868	1293	600	—
1916-17	826	70	345	191	856	1732	2155	178	2819	1294	1000	—
1917-18	1372	190	769	970	2190	3107	933	196	2502	1220	1400	—
1918-19	1963	442	952	2576	3200	7811	1513	1016	1943	1167	2300	1250
1919-20	3421	2928	4258	6745	10194	11607	1515	2138	2789	1506	2960	1980
1920-21	5000	3015	3300	6398	8415	9604	624	2702	2701	2155	3300	15 0
1921-22	1330	1563	2665	4861	7638	8058	336	2420	2193	803	3201	2476

Variation in the area under dry rice is more marked than in the case of wet rice, because land suitable for dry rice cultivation is more abundant and more rapidly available than for wet rice, hence the area under dry rice is more rapidly influenced by changes in the market price of rice than is the case with wet rice areas. Also dry rice cultivation is possibly more dependent on rainfall than wet rice since the latter is usually grown in localities where percolating water collects, in contrast to the dry rice areas which are more commonly found on sloping land and thus depend chiefly on the precipitation of rain.

VII. NATIVE METHODS OF MILLING.

Unhusked rice is known throughout the greater part of the East as "padi." In Malaya the husked raw rice is termed "bras" whilst when it is cooked is becomes "nasi." The native methods of preparing rice from padi suit the economic conditions of the people for at harvest, scarcity of labour, which is usually keenly felt in all large padi growing districts, renders it impossible to convert all the harvested padi into rice, consequently the padi is stored as such and is milled at leisure according to immediate requirements. Moreover, stored padi is much less subject to grain pests (rice weevil, etc.) than stored rice and further stored rice does not retain its flavour, whereas, stored padi does for quite a long time. After harvest the surplus stock is sold and the household requirement for the year is stored, most commonly in wooden bins, which may be incorporated in the construction of the cultivator's house, or form a sort of separate outhouse. Again they may consist of several large wooden boxes placed underneath the dwelling. In any case precautions are taken to maintain the grain in as dry a conditi n as possible and to keep out rats, birds and poultry.

In the conversion of their padi into rice, the Malays use two types of simple machines. In the commoner type the padi is pounded in an enclosed space, and in the other type, the husks are split by friction between revolving surfaces. The first type is known as the "lesong" and is so well known that it hardly merits description. There are three forms of "lesong" which differ according to the power used to pound the padi. The simplest is the "lesong tangan" or hand power "lesong" which is used by Tamils and Malays alike, and is usually worked by women. This consists of a block of wood, usually the bole of a tree, which is hollowed on one side to form a basin, capable of containing 2 to 4 gantangs of padi and the opposite side is flattened to render the whole steady. Padi is placed in this "mortar" and pounded with a heavy cylindrical piece of timber, rounded at the ends until the husk is split from the grains. Using the "lesong" a Malay woman can pound 3 gantangs of padi in an hour, while a Tamil woman usually works more rapidly. Sometimes, instead of a small "mortar" a larger one of some 12 gantangs' capacity is used and 2 or 3 women pound the padi instead of one. Three coolies working in harmony in this way can hull and winnow 20 to 25 gantangs in an hour. The second type is the "lesong kaki" worked by the feet. (Malay "kaki"—foot). In principle this is a huge hammer, 6 to 8 feet long and of which the handle, a 4 inch beam, is pivoted near its end between fixed uprights, while the head or striking part is arranged to drop into a "mortar" of hard wood. The striking part is usually iron-bound and often studded at its extremity with nails or spikes to reduce the rate of wear. Having fed the mortar with padi the worker stands on the end of the beam behind the pivot and by pressing with his foot on the beam depresses the short end, causing the hammer striking end to rise 2 to 3 feet. By suddenly releasing the

foot-pressure the hammer end drops with considerable force and pounds the padi in the "mortar." The weight of the hammer beam requires a pressure on the short end of some 15—30 lbs. each time to raise the hammer so that this work is by no means light.

Usually the padi is hulled, then winnowed roughly and hulled a second time. The percentage of rice broken by this method depends on the age and condition of the padi.

The third type is the "lesong ayer" which is identical with the "lesong kaki" except that water replaces coolie labour. The water is led to a simple over-shot wheel, which is connected to a stout shaft. The shaft has a short strong wooden projection which, when the water pressure causes the wheel and shaft to revolve, exerts pressure on the short end of the "lesong" thus raising the hammer. The rate at which the "lesong ayer" can hull padi depends on the water-power, the greater the water-pressure the more rapid will be the hammering, but there is a limit to the rate of hammering as it is necessary for a coolie to stir up the padi in the "mortar" frequently preferably after each stroke of the hammer otherwise the rice is much broken. Sometimes the pounding is done by a heavy beam arranged so as to slide up and down vertically between fixed slots and in this arrangement the water power is, of course, used to raise the beam (hammer) directly in place of using a pivot and downward pressure. Each lot of padi is pounded twice as in the case of other forms of "lesong." Generally a "lesong ayer" is arranged so that the water-power works six or eight hammers at a time, a six-hammer one being capable of hulling 40 to 45 gantangs of padi per hour. The cost of a "lesong ayer" depends largely on the ready supply of water-power. The wheel, shaft and one "lesong" should cost about $70/-, while six "lesong" together with water-wheel and shaft have been erected for $160/-.

The second type of native hand-mill is the "kisaran." This mill consists of two circular grinding surfaces of which the lower one is fixed while the upper one, which has a central aperture, is free to revolve on a pivot and can be adjusted to regulate the space separating it from the lower one. Each grinding surface is about 22 inches in diameter and is composed of chips of "bakau" wood from 1½ to 3 inches wide and 1/8 to ¼ inch in thickness, sunk to a depth of 4 to 5 inches into unbaked, but hardened, pottery or white-ant heap clay. The whole mass is bound around by bamboo basket work to give additional strength. The "bakau" chips are spaced about ¼ inch apart and arranged in rows running from the centre to the circumference of both grinding surfaces; the chips in each row being set at an angle of about 30 degrees to the radii of the surfaces. Underneath the lower grinding block, thoroughly dried coconut fibre is packed tightly into the basket work which is securely held in a wooden frame, tightly pegged to the ground. The effect of fibre-packing is to allow a small amount of resiliency to the whole mill, thus reducing the tendency of the hardened clay to crack under the vibration of rotation. The basket-work binding the upper mill-stone is continued upwards to form the receiptacle for the padi which is to be milled. This basket is usually of some seven "gantang" capacity. The padi enters the

mill through a central aperture in the upper grinding block and through the same aperture the pivot from the lower grinding block projects. This pivot keeps the upper grinding surface in position. On the pivot rests a wooden beam which is embedded in the clay mass of the upper grind-stone and protrudes through the basket-work about one foot on each side. Through this beam there is a central aperture to admit the padi from the receptacle to the mill, and across this aperture there is a simple arrangement for raising or lowering the beam and thus regulating the distance between the grinding surface. The upper grinding-block is made to revolve at any desired rate by a simple and effective, though ancient, mechanical device. This consists of a strong wooden rod some 4 to 5 feet long bearing near one end a stout iron peg which fits loosely into a socket in the protruding end of the beam just mentioned. The other end of the rod is fastened rigidly to the centre of a wooden hand-piece which is suspended from a convenient height (about 6 feet) above the mill. The coolie grasps the hand-rod with both hands and by lunging forwards slightly can rotate the upper grinding block with the expenditure of very little energy. A uniform rate of rotation is essential. The rice together with the escaped padi and chaff, after passing between the grinding surfaces is retained in a trough formed around the mill by the continuation of the basket work encircling the lower grind-stone. In practice the padi is put through the mill once and then winnowed. Afterwards unhusked padi is separated from the rice by rotating the mixture smartly in a circular basket tray when the padi, being lighter then the rice, comes to the top. The padi so obtained is removed and again put through the mill. Another method of separating the padi from the rice, is to allow the mixture to run down a long sieve placed at an inclination of about thirty degrees. The mesh of the sieve permits the rice to drop through into a container while the padi trickles over the sieve and is collected at the bottom in another compartment. A strong coolie can hull and winnow twenty "gantangs" of padi in an hour and each mill can cope with 3,500 to 5,000 gantangs without renewing the grinding surfaces. A "kisaran" in Krian costs about $30/- and can be ordered through the Department of Agriculture.

VIII. INTRODUCED METHODS OF MILLING.

Hitherto Chinese milling initiative has coped with the surplus crops of padi which, as already mentioned, are only produced in Kedah, Province Wellesley and Krian, but since the erection of the Government Rice Mill at Bagan Serai four years ago, a fair proportion of the annual production is milled by the Government, and thus though the Chinese are still very strong they no longer hold the milling industry as an absolute monopoly. The output of the large power mills, of which there are ten, varies from 200 to 600 bags of rice per day of ten hours, and in a good padi season, there is sufficient padi to keep these mills running for 9 to 10 months. Almost the entire output of rice from these mills is in the form known locally as "parboiled", that is, it is partially boiled usually by steam heat under pressure, before being milled. This partial boiling causes rice grain to swell slightly thus rendering the hulling much more efficient and reducing the percentage of broken rice to a minimum.

The padi is heated for about 10 minutes in metal cylinders by steam under pressure (about 20 pounds per square inch) and then delivered into sacks which are conveyed to the drying floor. The parboiled padi must be thoroughly dried, as quickly as possible, before it can be milled. If the padi is not well dried the percentage of broken rice in milling is greatly increased, and further if the drying is too prolonged, the quality of the resulting product is impaired. The parboiled rice is very slightly polished before being sold to the dealers who retail it to estates for consumption. Indian immigrant labourers are the chief consumers of this type of rice preferring it to non-boiled, because it is more quickly cooked and because they are accustomed to its distinctive flavour. About 10% of the output from the mills is not so treated but milled raw and highly polished for sale to the Chinese population which favours well-polished rice because of its white appearance.

In addition to these large commercial mills there is a movement amongst employers of labour in favour of small power mills of sufficient capacity to mill padi for the supply of rice to their native employees. Several causes contribute towards the origin of this movement. In the first place the purchase of local padi, raw or parboiled, and the hulling of it by estates, would encourage local production and thus retain in this country a part, at least, of the large sum of money annually spent on the importation of rice from other countries. For this reason Government is endeavouring to stimulate the interest of employers of labour in estate milling. Secondly, the milling of padi by estates has been proved to be a financial success on estates adjacent to large padi producing areas. Estates so situated, besides reducing their expenditure on rice, and retaining a margin of the profits to cover capital expenses, are in a position to supply it to their coolies at less than the local market rates and thus estate milling tends to attract and stabilise labour.

Moreover, estate milled rice is of better flavour than purchased rice and far more wholesome than polished rice and therefore superior in quality to rice bought from local mills or imported. Furthermore, the use of estate milled rice would tend to reduce the incidence of "beri-beri" which is a food deficiency disease due to the absence of neuritis-preventing vitamines from the dietary and is a serious menace to certain sections of our labour forces, particularly the Chinese and the Javanese. The Far East Association of Tropical Medicine (1) is making a real effort to combat this disease which is mainly due to the overmilling of rice which causes a loss of the outer layers of the grain containing the vitamines. Beri-beri causes enormous loss of human life with corresponding invalidism and disability so that this Association has resolved that it is urgently desirable that the various Governments concerned should take action to discourage the use of highly polished rice containing less than 0.4% of phosphorous pentoxide which Fraser and Stanton (2) demonstrated to be the criterion of a satisfactory standard of milling.

Local medical authorities administer doses of an extract from rice polishings to counteract "beri-beri," but methods of prevention of the disease are more desirable than methods for curing it. The most obvious method of combating the disease, which is really due to ignorance on the part of the consumers of polished rice, is educative propaganda to demonstrate the relative food values of polished and unpolished rice.

Even employers of labour and the leisured classes of Orientals frequently show profound ignorance of the relative merits of unpolished and polished rice and since it would not be a wise policy to tax imports of polished rice the only solutions to the "beri-beri" problem are increased local production, including milling to the required standard as mentioned above and education, principally amongst the Chinese.

The selection of the right type of mill is a matter for each estate manager or employer of labour to decide, giving due consideration to the availability of power and the amount of rice required to supply his labour force. The same considerations apply to the size of store, the area of drying floor and, when parboiled rice is desired, the capacity of the soaking tank and of the boiling arrangements. The following types of mills are recommended in their order of merit as adjudged by the Department of Agriculture.

Power Mills.

A. The Engelburg Type.

This type of machine is made by several firms of which the best known are Messrs. Douglas & Grant and Messrs. McKinnon, both of Scotland.

The mill may be obtained through Messrs. McAlister & Co., who have branches in the larger towns of Malaya, or through Messrs. Guthrie & Co., or Messrs. R. Young & Co., at Penang. It is sold under various names, "The Planters Mill," "British Rice Huller,"

"The Engelburg Huller," etc., and costs locally at the present time about $650.00 which includes a stout stand for the mill. Messrs. Douglas & Grant's price is £42 sterling F.O.B. Glasgow. The machine requires 10—12 horse-power to drive it efficiently. It is compact, sound and simple in construction and the wearing parts are easily replaced.

The optimum speed is 500 revolutions per minute. At this speed the mill outturn of rice should reach about one hundred gantangs (700 lbs.) per hour, unless the padi used is of poor quality when it may he necessary to mill it twice, thus reducing output to about 60 or 70 gantangs per hour. The mill works quite well at slower speeds also but more breakage results and usually a few grains of padi escape unhulled.

The mill is equally effective with raw and with parboiled padi, the only difference being that slightly more breakage of the rice is experienced in milling raw padi. The rice produced is not rendered deleterious from the point of view of "beri-beri" disease since the milling is limited to hulling, no polishing of the grain being effected. The cost of erecting this mill should be small unless a separate mill room is required. The cost of fitting the machine to existing rubber machinery would vary according to the length of belting and the number of pulleys required and whether any additional shafts were necessary. A drying-floor is advisable since the padi must be thoroughly dry before being milled otherwise the percentage of broken rice is certain to be high. If parboiled rice is desired a drying-floor is a necessity.

The cost of a cement drying-floor should not exceed the rate of one dollar for every four square feet and the floor should slope slightly to promote rapid drying. The area of drying surface required would depend on the amount of padi to be milled daily. On the average thirty square feet is sufficient for drying thirty gantangs of padi, which is equivalent to twelve gantangs of rice, but at least double the day's requirement of padi should be dried daily until a fair stock of dry padi is obtained. In the case of parboiled rice the padi must be soaked in water for twenty-four hours, preferably with a few changes of water, and this is usually done in a cement tank of the required capacity, having an outlet pipe at the bottom for changing the water. The parboiling is most easily performed by using an open shallow iron pan ("kwali") capable of boiling about sixty gantangs of padi. This is fixed up over a brick and cement fireplace. A combination of 2 or 3 pans over one fireplace works well. On one estate the total cost of all the soaking and boiling arrangements was less than $120.00 including the shed under which they were placed. Whenever estate milling is contemplated a rat-proof store is essential since rats are large consumers of stored grain, and unless they are rigidly excluded, considerable losses of grain will be experienced. This is usually the most expensive item in setting up small power mills on estates, but its cost varies according to the nature of the building available, (if any), the cost of bricks, corrugated iron sheeting, close mesh wire-netting, etc. Another form of this machine includes a polishing drum. This form may also be used with safety from the point of view of beri-beri though it is better to remove half the polishing flanges from the inside of the polishing drum.

B. Under-Runner Hulling Mill.

This machine is manufactured by Messrs. Douglas & Grant (catalogue page B. 3) and retailed through Messrs. R. Young & Co., Penang or through Messrs. McAlister & Coy's branches. It is sold in four sizes of capacities varying from 300—900 "gantangs" of padi per hour that is, equal to an outturn of 120- -400 gantangs of clean rice. The smallest size costs about $750.00 and the largest $1,650.00 at the present time. The power required for those mills varies from 2 to 4½ H.P. according to size. As this is purely a hulling machine, the hulls must, after milling, be separated from the rice either by wind or by some form of winnowing machine.

The hand-winnowing machine described in Section V is cheap, durable and effective and most local carpenters can make them at reasonable prices or they can be ordered through the Department of Agriculture. Power winnowers can also be used, but they are expensive and no more effective than hand machines.

Hand Power Machines.

The only hand-power machine which can be recommended with confidence is the improved hand power rice huller, shipped by Messrs. Douglas & Grant (catalogue page R. 1) and obtainable locally through the Agents already mentioned in connection with power machines.

This mill is a combined huller and winnower. It is simple in design, very compact, easily adjusted, strongly constructed and practically 'foolproof.' The hopper is fitted with an efficient adjustable feeder which delivers the padi to the hulling discs in an even stream and a neat winnowing attachment blows away all the husks after hulling. The resulting rice is very wholesome and free from any injurious effects from the point of view of "beri-beri." This mill is eminently suitable for small estates not requiring a large amount of rice daily as its outturn is only 15 gantangs of rice per hour. The hand labour involved in working it is very light or the machine might be fixed to a motor cycle pulley as the power required is considerably less than 1 H.P. Care must be taken that padi is free from stones, nails or other hard particles which are liable to damage the grinding surfaces, before milling. The mill costs $400.00 and spare parts are readily available.

In case the supply of padi for milling in this machine, is very mixed, as it often is, the makers have designed a special hand-power compartment separator which divides the hulled from the unhulled rice after the first milling and the unhulled rice is then passed through the mill a second time. This Separator costs $500.00 and by using it the grinding discs of the huller can be set so that practically no rice is broken, unless the padi is very inferior or old stock. The separator can deal with 25 gantangs of milled rice per hour. A much cheaper and equally efficient separator can be made with a strip of strong wire netting of three-sixteenths inch mesh, and about six feet long, by encasing it with wood to make it rigid and placing it at an inclination of about 30 degrees to the horizontal. The mixture of rice and padi

is poured down this inclined riddle, the rice dropping through while the padi is collected at the bottom of the sieve. If the rice is very small grained it may be necessary to pass it down the sieve twice or even three times.

Should the padi be parboiled before milling, practically no grains escape unhulled and the amount of breakage is immaterial.

Milling by-products.

The chief by-products obtained in milling rice are broken rice, bran and hulls. Straw, though not sent to the mills, may also be classed as a by-product.

Broken-rice.—In milling padi a certain amount, usually around six per cent., of the grain is broken for various reasons and passes through the milling screens.

The chief causes of breakage include under-drying, over-drying, unripe grain, variation in size of grain, and faulty adjustment of the mill. Under-dried or unripe padi becomes chalky and crumbles up in milling; overdried padi becomes too brittle and splinters readily. Inferior grain shows a wide range of variation in size and thus renders adjustment of the mill a difficult matter. Grading the padi before milling corrects this factor to a certain extent, but sufficient grading is rarely done. The correct adjustment of the mill can only be achieved by experience and depends on regular supplies of the same types of padi. This by-product is found to contain a large percentage of the embryo of the kernals and hence it produces a very nutritious and palatable food, but on account of its high fat content it turns rancid rapidly. It provides an excellent feed for cattle, pigs and poultry, and is sometimes used for human consumption in years of shortage. Table X shows the food values of the various by-products of rice compared with wheat and oats.

Table X.

——	Water. %	Ash. %	Pro-tein. %	Fat. %	Carbohy-drate. %	Fibre. %
Padi ...	10.24	9.45	7.44	2.24	65.50	9.29
Rice Straw ...	11.80	12.99	3.25	0.62	36.30	35.01
Rice Hulls ...	8.97	18.29	3.50	0.49	26.96	41.89
Rice Bran ...	10.67	11.35	10.38	10.44	54.26	14.75
Broken Rice ...	11.79	...	8.19	2.56	77.46	...
Unpolished Rice ...	...	..	9.88	...	69.67	...
Polished Rice ...	...	...	6.56	...	77.55	...
Maize ...	12.20	1.50	10.40	5.00	69.40	1.50
Wheat ...	10 20	1.90	12.40	2.10	71.20	2.20
Oats ...	9.20	3.50	12.40	4.40	59.60	10.90
Barley ...	9.30	2.70	11.50	2.10	69.80	4.60

Rice Bran :—This by-product is usually sold in two grades, (occasionally three), according to the amount of finely broken rice it centains. The bran contains most of the protein of the rice grain, some ground kernel and hull. The amount of bran produced depends largely on the adjustment of the mill and the type of milling. In using the native "lesong" the amount of bran produced is considerable. Bran forms a rich food for the stock-yard, but does not keep long on acconnt of its high fat content.

It is an excellent food for horses, chickens, hogs and cattle, but given as a sole diet is liable to cause stomach trouble. It should be mixed with sweet potatoes, maize, linseed cake, etc, according to the stock.

An extract from bran, particularly the bran derived from the polishing machine, is used medicinally in the treatment of beri-beri in many hospitals in the Tropics.

Rice Hulls.—Hulls are fibrous and unpalatable and of no value as a food because they contain little digestible matter. They are chiefly used as fuel to drive the mills, since they are inexpensive and burn with little smoke. The ash derived from the hulls is occasionally strewn on the padi fields as a manure if labour is cheap but the practice has little to recommend it since the ash contains less than one per cent of potash and of phosphoric acid. The most economical method of applying the ashes is to strew them in the irrigation water and thus let them be carried to the fields. Hulls make a useful nitrogenous manure for rice, fruit trees or gardens, and are frequently used for this purpose in the Malay holdings.

Rice Straw.—The straw when properly cured provides an excellent fodder, rich in protein and carbohydrates. It is occasionally woven into mats and sacks and can be manufactured into paper, as in Japan. In Malaya. the straw has no economic value since the climate provides an abundant supply of fresh grasses for our limited stock of cattle and horses and it does not pay to convey it to the towns for sale as fodder. It is possible that finely chopped straw or compressed baled straw would pay, if a large market was accessible, but the local demand for straw is very small.

The question of utilizing padi straw has been referred to in Section IV where it was pointed out that the straw is usually left on the fields because it had no monetary value. The inadvisability of removing the straw because of its manurial value, unless other manures are applied, was also mentioned.

1. Resolutions of the 4th Congress of the Far Eastern Association of Tropical Medicine.

2. Etiology of Beri-beri—Fraser and Stanton—Studies of the Institute of Medical Research F.M.S., 1911.

IX. PESTS AND DISEASES.

Padi, like most cultivated plants, is subject to the attacks of pests. In many districts of Malaya constant watchfulness has to be exercised to prevent serious crop losses owing to the depredations of rats and birds; whilst various insects are annually responsible for much damage.

Rats (i) are often particularly destructive to seedlings and grain, for example, it has been estimated that in the Krian district of Perak alone, this pest destroys each year at least six per cent of the crop or approximately one million gantangs of padi, which quantity would be sufficient to feed 10,000 Malays for one year. This estimate, however does not take into account the damage done to padi in store which must be considerable. Rats are usually more numerous in fields which adjoin kampongs or uncultivated land for in these places they can take refuge and breed during the period between harvest and sowing time.

The only really effective system of controlling this pest is to adopt a combination of methods and put these in practice throughout each padi area. Although this may not be practicable at the present time yet a great deal of good may be done by combined local effort along the following lines.

Preventive Measures.—These include the removal and destruction of all accumulations of waste material such as straw, husk and chaff: the rat-proofing of buildings and bins; the filling in of barrows with sand, glass, tar or similar material; the fumigation from to time of unprotected store-houses, burrows and bins—the best fumigant is carbon bisulphide,—the protection and where necessary, the care of natural enemies for example, herons, owls, snakes, hawks, cats, dogs and the mongoose.

Methods of Destruction.—These comprise trapping, hunting and the use of poisons. There are many forms of traps employed such as guillotine, cage, deadfall and barrel, but as rats are so cunning these are usually only effective for a limited time in any one place although their usefulness may be greatly increased by frequent change of position and by varying the nature of the bait. By systematically hunting rats in houses, stores, trees and fields whereever practicable much good may be done. Varnish and bird lime make effective traps also.

Poisons.—Stomach poisons in tempting baits are quite extensively used locally but great caution has to be exercised with the majority of these to prevent their being eaten by useful domestic animals and birds. The poisons commonly used are white arsenic, sodium arsenite, barium carbonate and phosphorus paste. These are

mixed with suitable baits and placed in the haunts of the rats. The poisoned baits, made up as small cakes about an inch in diameter may be coated thinly with paraffin wax to preserve them from rain or mildew and dropped about the fields at about ten feet intervals. Prepared in this manner, baits are very effective.

Full details of the preparation of the baits are given in the Agricultural Bulletin Vol. IX., No. 4, 1921, pp 272-274. It may be mentioned that in Krian an attractive bait is provided by the common green grass-hopper. The insect is caught and killed and a pinch of arsenic or other poison is inserted into a split made along the back of the insect. The bait is then placed in a suitable position usually amongst a small heap of padi husks.

The rhizomes of a local plant the "Siak-siak" (*Dianella ensifolia*) are also used in some districts. In this case mature rhizomes are pounded up and boiled with ten times their volume of rice and the bait placed about the fields in small heaps. An examination of the "Siak-siak" rhizomes' showed that they contained large quantities of fine needle shaped crystals of calcium oxalate which possibly act as a powerful mechanical irritant when ingested.

Birds.—Numerous small birds attack the padi when in ear and several ingenious and many laborious methods are adopted for scaring them away from ripening crops. The most common method is to place empty kerosine oil tins on tall sticks placed upright about the fields. All these sticks are then connected by a long rattan or "mengkuang" string. A child pulls one end of this string at frequent intervals thus causing the tins to jangle and the noise scares the birds away.

The poisons used to destroy rats can be used against birds also, the strengths of the several poisons being reduced to one third of those recommended for rats. Much loss of grain can be prevented in each area if planters so arrange the planting of different varieties that they will all mature simultaneously. In varietal tests it has been found that early ripening plots are almost completely consumed by birds, so that all varieties are now planted so that they may mature at approximately the same time.

INSECTS:

At the outset it may be mentioned that any unfavourable conditions which tend to weaken or check the growth of the padi plant such as poor soil, too much water, drought, stagnant water and weeds, also increase the liability of the plants to be damaged or killed by insect pests.

The chief pests which suck the juices of the plant and grain are the bugs "Kutu bruang" (*Podops coarctata*) and "Pianggang" (*Leptocorisa varicornis* and other species). The "kutu bruang" is black in colour, about ½ inch in length and slightly less in breadth. The nymphs and adults suck the sap from the base of the plants and when present in large numbers so

weaken it that it is unable to produce any grain. No satisfactory method for controlling the pest has been found for places where water for flooding the fields is not available. It has been frequently shown that if attacked padi fields are flooded the nymphs and adults rise to the surface of the water when they can be collected and destroyed. It has also been observed that this pest is capable of living in the stubble and growth of the previous crop for it has been found in lands newly prepared for planting the following crop. Eggs, nymphs and adults often appear in the nursery beds and if attention is paid to planting out only clean seedings the chances of damage by this pest would be reduced. An egg parasite has also been found which checks this pest.

The "Pianggang" commonly causes extensive losses of padi. It is recognised by its greenish brown colour, elongated body and its habit of sucking the juices of the developing grain. Sucked grains are readily recognised by the characteristic circular punctures one-thirty-second of an inch diameter made by this bug. The pest is capable of living on the inflorescences of various grasses and these may provide food for it after the padi is harvested and until the grain of the new crop has reached the milk stage. Preventive measures for controlling the insect such as keeping down grasses in the vicinity of the growing padi fields especially during the period when the land is not being cultivated should be adopted. During an attack the "Pianggang" can be reduced in number by systematically collecting it in hand-nets or by drawing elongated bags previously coated inside with some sticky material, such as crude oil emulsion, quickly across the fields. The eggs which are brownish in colour are conspicuous. They are laid in chain formation chiefly on the upper surface of the leaves and should be collected.

It is said that the pest will collect on baits consisting of putrid-meat placed in muslin bags and suspended in the fields, and that a large number can be caught in this way.

The small green Jassid bug known as "binak" (*Nephotettix bipunctatus*) which sucks the juices of the padi leaves is often quite a serious pest shortly after the padi is planted. A weak solution of kerosine emulsion, not exceeding 2%, sprayed on the plants is an effective remedy against this insect.

The stem-boring insects which are particularly troublesome and cause much damage are *Schoenobius bipunctifer* and *Diatraea auricilia*. These, besides killing the flowering shoots, tend to retard the ripening of the crop or to break its uniformity, thus causing additional loss at harvest. The former is usually predominent but the latter was more prominent in the earlier part of the 1921 season in the Krian district and had not been previously recorded as a pest of padi in Malaya. The preventive methods discussed for the control of the padi bugs already referred to, are applicable to these borers also. In small areas the application of "tuba" (the juice extracted from *Derris elliptica*) is most effective, but "tuba" can only be used where the padi is grown in water which is not mixed later with the drinking supply. A bird called locally Ruak-Ruak is said to keep this pest in check but the statement cannot be authenticated.

Among the leaf-eating insects which cause damage from time to time are larvae of the following: *Parnara mathias* which rolls the leaves and feeds inside them; *Nymphula depunctalis* and *Melanitis ismene* which are semi-aquatic and live in cases made of rolled pieces of leaves: *Spodoptera pecten* which may occur in enormous numbers when conditions suitable for its rapid increase prevail.

A minute eel-worm which was identified by the late Government Entomologist as *Tylenchus augustus* is a well-known parasite of padi in India. It occurs in the Krian district and causes some damage to roots and young shoots by sucking out their juices, but is not so far known as a serious pest. The infested plants have a sickly stunted appearance. Their leaves are pallid, and in the later stages of an attack the leaf-sheathes have brownish marks and the ears fail to mature.

The mole-cricket "Sorok" (*Grylotalpa borealis*) sometimes appears in wet padi nurseries where the soil has been allowed to remain above the water level for a few days or in dry nurseries. This pest which often destroys large numbers of seedlings can be guarded against, provided water is available, by lowering the nursery beds until they are just covered with water. In dry nurseries or where insufficient water is available, they may be hunted out of their burrows and killed or tempted with poison baits. A good bait consists of 30 parts broken rice or rice bran, 2 parts sugar, 1 part white arsenic and 10 parts juice of limes. The bran and arsenic are first mixed thoroughly. Then the sugar is dissolved in water and the lime juice added and this syrup is stirred into the bran to make a stiff paste. The paste should be placed about in small heaps 5 or 6 feet apart. About 4 katties of paste should be enough for an acre.

Grass-hoppers may also attack the nurseries but rarely do much damage. They may be given the bait used for cricket-moles or caught in large bag traps if very numerous.

The general control of padi pests presents many difficult problems. From an entomological standpoint, the practices of allowing stubble, selfsown padi etc., to grow after the crop is harvested is to be strongly deprecated because ideal conditions are maintained for the insects to feed and breed until the padi for the following crop is shown, though from the economic aspect the destruction of grasses and stubble is inadvisable except in extreme cases.

The eggs of *Podops*, *Schoenobius*, *Leptocorisa* and *Spodoptera* are frequently present in nursery plants and on account of the cultivator's ignorance are taken to the field on the seedlings whereas, they should be destroyed before the young plants are removed from the nurseries.

Pests of Stored Grain: There are several insect pests that attack padi and rice in store, and often cause serious losses. The most important of these are:—

Rice weevil (*Calandra oryzae*)
Angumois grain moth (*Sitotoga cerealella*)
Mediterranian flour moth (*Esphestria Kuhniella*)
Small Red beetle (*Tribolium castaneum*)
Saw-toothed grain beetle (*Silvanus surinamensis*)

Owing to its protecting husk, padi is less subject to the attacks of these pests than rice, hence the custom of the Malays to store the grain as padi and convert it into rice when required. The control of grain pests is most difficult in places where the storage rooms, bins or other receptacles cannot be made and kept air-tight. If air-tight they can be readily fumigated and all the insects killed. The most effective fumigant is Carbon bisulphide which is used at the rate of 2-3 lbs of liquid to every 1,000 cubic feet of space, but the gas given off is highly inflammable and poisonous, hence extreme care has to be exercised when employing it. A great deal may be done in the matter of preventing insect attacks by thoroughly cleaning out stores and bins before storing grain in them. In the case of bins or barrels, steaming or scouring with boiling water to kill any pests that may be hiding in cracks or crannies is beneficial, provided that these receptacles are thoroughly sun-dried afterwards, When the padi is placed in stores or bins, it is important that these should be kept tightly closed, and only opened as required. It is needless to add that all grain should be perfectly dry before it is stored.

Much progress has been made recently by the Entomological Division of the Department of Agriculture with the study of the pests attacking the padi plant locally and the results will shortly be published.

Diseases.—Fungus diseases of padi are not unknown but do not, as a rule, cause serious losses of crop in Malaya. Occasionally "Smut" (*Ustilago* sp.) may attack the Grain of certain varieties and a species of "Phyllosticta" has been found on the leaves.

1. The Destruction of Rats.—H. W. Jack—Agr. Bull. F.M.S., Vol IX., No. 4, 1921.

X. THE ECONOMICS OF RICE PRODUCTION.

The cultivation of rice has had its vicissitudes. Coincident with the enormous and rapid development of the commercial resources of the country, the cultivation of rice tended to decline until several factors acting together reminded the Malay that rubber and tin were not edible and that the policy of depending entirely on imported foodstuffs was not always wise. Nevertheless, apart from these factors and the ease of gaining other employment, the decline may also be attributed to the poor crops of rice obtained from much of the land by the customary methods of tillage. The cultivation of the rice fields is enforced in certain areas, but such compulsion is rarely necessary where the soil is capable of producing anything like a reasonably profitable crop and in poor land where crops are precarious such compulsion is unjustifiable.

The Malay prefers life in a 'kampong,' as a rule, but he harbours no delusions about the labour of following the plough, or swinging the "changkol" and will not indulge in these practices unless he is spurred on by the prospect of a fair return for his labours; this should cause no surprise, for what farmer worthy the name would think of cultivating his land, regardless of the returns at harvest.

The appeal to the health and charm of rural life is vain amongst folk who must earn their daily bread and not until the Malay can be assured of a certain profit from padi cultivation and one which will compare favourably with that to be derived from other occupations, is it reasonable to expect him to show more enthusiasm for the cultivation of his rice fields. Padi production is doubtless largely affected by the economic law of diminishing utility, for while the Malay thoroughly realises the advisability of producing sufficient to supply his own wants, he sees no point in labouring to produce additional padi for which he can hope to gain little profit at normal prices. Next to his own food supply, his chief incentive to work is his desire to obtain some material advantage, usually measured in money, and his reward for additional work in the padi fields is so small, that it is insufficiently attractive to arouse his energies.

The total efficiency of production depends on several conditions. The chief of these is the aid which nature supplies in the fertility of the soil which, as has already been mentioned, is very variable and though land rarely ceases to respond to increased cultivation, it often affords only a diminishing rate of return. Other conditions include the supply, average ability and industry of labour, the demand for labour, the rent of land, the incidence of pests, water-supply, the accessibility of markets, the wealth of the cultivators, industrial organisation, etc. The urgent demand for labour in the rubber industry and the comparative ease of estate work coupled with high wages and the cheapness of imported rice seriously threatened to ruin

the rice industry until restricted shipping curtailed imported food supplies during the war. The recent slump in the rubber industry once more compelled the Malay to attend to his rice fields, but without these natural and unforeseen forces, the Malay is unlikely to apply arduous toil to the production of meagre and unprofitable crops of padi; and this is only natural. Thus, unless increase of population and the consequent struggle for existance exercises the necessary compulsion, all but the most fertile rice lands are liable to be abandoned, as long as the rubber industry continues to prosper. The average costs of production vary considerably and except in Krian are extremely difficult to estimate in terms of cash since communal labour is adopted to a large extent. In the Krian district the cost of production can be readily gauged since contract work is common because many of the Malays are comparatively wealthy and Malays in easy circumstances rarely do the hard work which rice cultivation involves. The cost of cultivation and harvest per acre on first class land works out as follows;—

(1)	Preparation of nursery and sowing same ...	$ .80
(2)	Seed 2 gantangs @ 12 cents per gantang ...	.24
(3)	Cutting grass and weeds	4.50
(4)	Removing weeds etc.	4.50
(5)	First and second transplantations ...	1.50
(6)	Final transplantation	6.00
(7)	Weeding	3.00
(8)	Rent and water rate (80 cts.) & ($3.00) ...	3.80
(9)	Harvest—15% of crop (say 500 gantangs padi) @ 11½ cts. per gantang	8.63
		32.97
	Gross returns 500 gantangs @ 11½ cts. per gantang	$57.50
		32.97
	Profit per acre	$24.53

Thus in first class land in Krian, even on contract rates, padi production is profitable and doubtless the profits are much greater in the case of communal labour or where each family does its own cultivation. The price (about $225.00 per acre) which this type of land commands in Krian confirms its profitable return moreover those who do not rent this type of land from Goverament are always willing to hire it privately at $16.00 per acre per season.

On second class land in the same district, the profit approximates $7.00 per acre when contract labour is employed while third class land can only be cultivated profitably by the owners of land in good years and can never show profits if contract labour is employed.

On harder soils where ploughing becomes necessary the costs of production are considerably higher and profits are proportionally smaller, because buffaloes are scarce and demand high rates of hire and not only is the land ploughed, but it is also harrowed to destroy the weeds and rolled to reduce the soil to an even texture. Kuala Kangsar district affords a good example of this type of land. In this district cultivation and harvesting operations work out as follows:—

(1)	Preparation of nursery and sowing ...	$ 1.50
(2)	Cost of seed 3—4 gantangs	.40
(3)	Cutting weeds (frequently not done) ...	4.50
(4)	Ploughing 7 days @ $1.20 per day ...	8.40
(5)	Harrowing 3 days @ $1.20 per day ...	3.60
(6)	Rolling 3 days @ $1.20 per day ...	3.60
(7)	Transplanting (including preparation of seedlings)	6.00
(8)	Weeding	3.00
(9)	Repairing water courses and "batas" ...	1.20
(10)	Rent	1.00
(11)	Harvesting, threshing, winnowing ...	14.40
	Total ...	$47.60
	Gross returns, 400 gantangs padi at 12 cents per gantangs	48.00
	Profit per acre per season	$ .40
	Profit, if the cutting of weeds is ommitted ...	$ 4.90

Under this type of cultivation the yields vary betweed 200 and 500 gantangs of padi and 400 has been taken as the average from good land to show a profitable margin, though in reality the average is lower. On poor lands, therefore, no cash profit can be shown.

The above figures represent the costs of padi cultivation when undertaken by an outsider employing free labour and also represent its position compared with other industries e.g. rubber. They were in, fact, the actual contract or labour rates fixed in experimental areas, in both districts.

The ordinary cultivator who owns his own land, buffalo and implements and works the land himself (aided by his family) can doubtless show better returns, for the labour of cultivation only requires the work of three persons per acre for 25 to 35 days per season.

The cost of working an acre of padi land varies in different districts but in all probability thirty-two dollars represents the lowest cash equivalent for efficient cultivation. True, the costs are reduced in some districts (usually poor ones) below this figure by omitting or neglecting some part of the cultivation at the expense of the crop, but this is false economy and should be discouraged. The point of note is, the cost of cultivation in bad and good land is approximately the same so that the possible profits depend entirely on the nature of

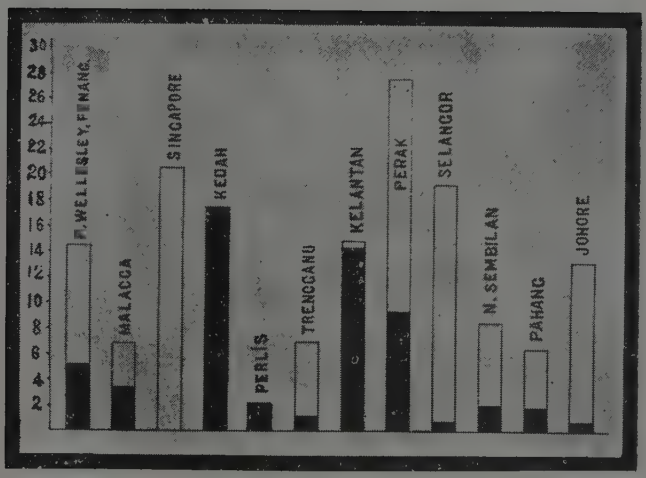

Diagram A. The ratio between Consumption and Production (black) in each State.

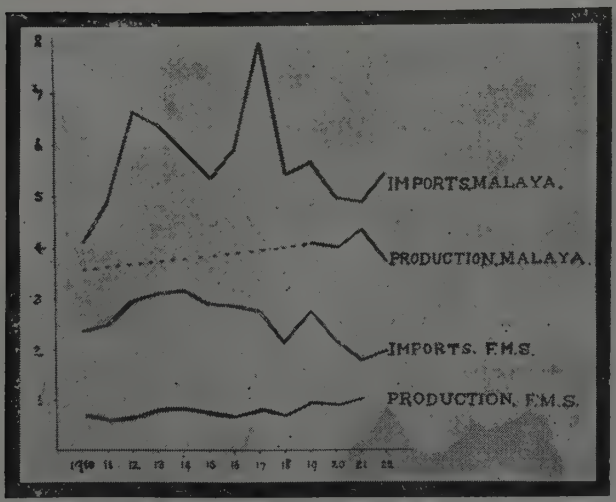

Diagram B. The Variation in Imports and Production in millions of pikuls of rice.

the fields (including water-supply). Under poor rice growing conditions, in terms of cash, cultivation results in heavy loss, but from the point of view of the grower it is nevertheless a profitable transaction because his holding, averaging between 2 and 3 acres, supplies the staple article of diet for himself and his family for the year at the cost of about eighty days labour in all. For this reason, thousands of acres of poor padi land are cultivated annually in Malaya. For example the "tenggala" system of cultivation in Pahang if regarded as an investment can only be classed as a dismal failure whereas from the Malay view point, it is the source of his food supply and as such is profitable in his eyes.

Padi cultivation is essentially a Malay industry. The large numbers of imported Indian and Chinese coolies are employed mainly on estates and tin mines respectively, they have little chance of acquiring or renting padi land and few of them have had any experience of the rice crop, consequently in estimating the total possible production of Malaya, due consideration must be given to the statistics of Malay population, for, for all practical purposes this element only of our population is engaged in padi production. The 1921 Census shows that there are 892,106 Malays of working age (15—55 years) in the Peninsula out of a total Malay population of 1,594,699. Of these 453,246 are classed as "rice planters" and to this number may be added those classed as "estate owners" and "planters unspecified," nubering 57,483 since it is quite conceivable that many of them may own padi land or plant padi, making a total of 510,729 or 57% of the total Malay population of working age. The remaining 311,377 (or 43%) of working age are engaged mainly in fishing (37,805) and as agricultural coolies on estates (95,950) and in other necessary pursuits. Therefore 510,729 are responsible for the planting of the rice fields of Malaya which during 1921-22 season covered 669,262 acres, that is, each adult Malay cultivated 1.31 acre which falls very little short of the maximum area which one adult could cultivate efficiently.

Again assuming every male over 15 years of age to be head of a family there are 336,680 families in Malaya. Assuming that of these 20% are engaged in industries other than rice production (in reality there are more) the remaining 80% or 263,344 families cultivate annually 669,262 acres per family, or approximately 80% of the area which one family can cultivate properly.

The average rate of production of wet padi in Malaya is 203 gantangs per acre and 100 gantangs of padi are equivalent to 42 gantangs of rice therefore 2.48 acres produce 210 gantangs of rice. This amount of rice is sufficient to feed four Malays reckoning on an average consumption for all ages of 50 gantangs per annum; or 2 adults and three children, reckoning 30 gantangs per child under 15, 60 gantangs per man of working age and 50 gantangs for women and old men.

Regarding the problem of production from another aspect 135,991,280 gantangs of padi (57,116,337 gantangs of rice) which represent the average annual production of Malaya for the last three

years are sufficient to feed 1,142,326 Malays of all ages or 72% of the Malay population. Over 30% of the total population consists of children under 15 years of age so that if due allowance is made for these the annual prodnction is sufficient to feed approximately 1,325,000 or over 80% of the Malay population. The above considerations show that the Malays almost provide for their own rice supply and could not possibly produce much more padi because suitable land is difficult to find, and one family cannot efficiently cultivate more than 3 acres. The total population of the Malay Peninsula is 3,322,603. Asming us an average consumption of rice of 50 gantangs per head per annum for all ages and calculating on the present rate of production of padi per acre (203 gantangs) 1,954,472 acres of land, (or roughly three times the present area) would be required to be cultivated annually to supply the total needs of the Peninsula. At the present time it would be imposible to cultivate this area because skilled labour, which is essential, is not available in sufficient number. Also it would not be possible to find suitable land to aggregate to this area, so that the most rapid means of increasing local production must lie along the lines of improvement of the conditions affecting existing areas and of increasing average crops. In the past it has been regarded uneconomic to aim at the production of our total food requirements. It was assumed that tin and rubber were the essential industries of the country and that they should be developed at the cost of food production on the grounds that imports of rice were cheap and plentiful. The late war has disclosed the erroneous nature of this policy and efforts are now being made to extend the present area under padi gradually and to stimulate rice production generally. There is no hope of the country being able to produce its total requirements of rice under present agricultural conditions and on account of scarcity of skilled labour, though there may be sufficient land available in the unopened tracts of Kedah, Kelantan, Trengganu, Selangor and other parts of the Peninsula.

That the tin and rubber industries supply the finances which defray the cost of administration of our Government is undoubted, but without rice a large proportion of the labour masses engaged in these industries could not be kept in the country, so that rice is, in reality, the first essential requirement of Malaya.

It is possible that a crisis such as that which occured in 1917-1918 may never happen again, but is it not advisable to keep the phantom of the rice shortage of that period dimly in view, particularly where the alienation of land is concerned, so that land which is eminently suitable for padi cultivation may be kept for that purpose and protected from harmful silting or the contamination of water supplies.?

The seriousness of the position of this country in regard to rice supplies is indicated in diagram A which portrays the ratio between consumption and production in the various States and Settlements in Malaya. Each column represents the proportionate consumption or requirements in the State or Settlement indicated and the blackened part of each column represents the average annual production. Thus Kedah, Perlis and Kelantan (with a very small import) are the only

States in which the supply satisfies the demand. Malacca and Pahang produce almost half their consumption. Perak, Penang and Province Wellesley and Negri Sembilan produce approximately one-third of their requirements and Trengganu only about one-sixth. In Selangor, Johore and Singapore the production is negligible.

The average annual import of rice into Malaya from 1910 to 1922 is 5,462,000 pickuls, if the abnormal import of 1917 is omitted. The average annual production of Malaya calculated on the four years 1919 to 1922 is 3,578,700 pikuls of rice (135,991,280 gantangs of padi therefore the ratio of production to imports is 5 : 8 in round numbers.

As regards the Federated Malay States alone the figures are somewhat worse. The average imports since 1910 being 2,592,000 as against an average production of 810,000 pikuls so that the ratio of production to imports is roughly 1 : 3. The average cost of importing rice to feed our labour masses since 1910 is over $34,000,000 per annum.

Diagram B shows the annual variation in production and imports of rice into the Federated Malay States and the imports into Malaya since 1910. Unfortunately, the figures of production of Malaya are not available prior to 1919, since no crop returns were prepared in Kedah or Kelantan before that date. These two states produce nearly 60% of our locally grown supply, but since they have been little affected by the rubber industry and their populations are chiefly devoted to rice growing, it might be assumed, with a fair degree of safety, that their production was maintained at an average, allowing for a small increase in proportion to the increase of population. The curves of imports are prepared from the figures in table XI which were kindly supplied by the Commissioner of Trades and Customs and the curves of production are prepared from the padi returns annually collected from District Officers.

From the curves it can be seen that the imports correspond very closely to the variations in the state of the rubber industry. Thus, the 1910 rubber boom caused imports to increase steadily in the Federated Malay States and rapidly in Malaya as a whole, until the outbreak of war in 1914 which depressed the imports in 1915. The high price of rubber (fifty pence) in January 1916, again had a stimulating effect on the imports but this was soon set back in the Federated Malay States by the enhanced price which rice demanded culminating in 1920 in costing the country more than one hundred million dollars. The only point in the import curves which does not correspond with the condition of the rubber industry is the import of over eight million pikuls of rice into Malaya in 1917.

As regards production in the Federated Malay States the curve follows the progress of the industry fairly uniformly. Thus, the curve traces the fall in the price of rubber from 1910 to 1911 and thereafter the comparative steadiness of the price until native holdings of rubber became profitable in 1913. This was followed by a marked tendency to neglect rice for the more paying cultivation of rubber.

until shortage of ships forced up the price of rice in 1917. This increase in production would undoubtedly have been maintained in 1918 had not the influenza epidemic of that year caused a decided shortage of skilled labour with consequent smaller acreages under rice.

This increased cost of imported rice followed by the slump in the rubber industry combined to cause a continued increase in production right up to 1922. In Malaya as a whole the production shows a heavy decrease from 1921 due, partly, to the reduced price of imported rice which immediately affected the rice industry adversely in those States which were mainly devoted to rice cultivation, but chiefly, to the unfortunate weather conditions experienced in that season in Kedah, a state which furnishes one third of our annual production and in which that padi season was "bad beyond all precedent."

The gradual increase of Malay population, (nearly 2% per annum) has naturally, a slight stimulating effect on the production of rice, but the big increases in imports are almost entirely due to the employment of large numbers of immigrant coolies on rubber estates.

In passing, it may be mentioned that the bulk of our rice imports comes from Burma, which is the cheapest and steadiest market available. Imports from Siam and Indo-China are variable in amount since their exports depend entirely on the season's production. Moreover, they do not export cheap rice.

The contention that Malaya is not a rice growing country, is hardly applicable since our average production of 1,020 lbs. per acre per annum (wet and dry) is higher than the average in Burma and India and we have big areas which can produce as much as 2,600 lbs. per annum. Approximately, half of our padi is produced in small areas in narrow valleys along the banks of streams and rivers where pests notably pigs, rats and birds abound and damage every crop considerably. The large flat coastal areas which are much more suitable to rice production and much less liable to animal pests have been planted up with permanent crops which could be better grown on the undulating foothills further inland. The rubber boom of 1910 is responsible for this state of affairs but there are still available several large alluvial areas suitable for rice cultivation, which if irrigated and made occupiable would attract padi planters Naturally the costs of irrigating and rendering large areas fit for occupation would be heavy, but if due consideration is given to the fact that each family settled on such land would produce its own rice supply and in addition, enough to feed two or possibly three other families, then the matter assumes an important aspect. Besides thus tending to reduce our large annual imports of rice, which are a heavy drain on the resources of the country, such settlers would become available for other types of industry and thus serve the country as a double asset. Malay settlers might not be immediately available in the vicinity of large areas suitable for padi cultivation but provided that the land is good, the water supply assured and that the area is made readily accessible, suitable settlers could be induced to leave districts where

no good padi land exists or where it has all been planted to permanent crops. Moreover, the Malay population is annually increasing by over 20,000 souls and this increase could be used to develop newly opened rice lands provided that they were easy of access.

TABLE XI.

Imports and Exports of Rice (including padi calculated as rice) in Thousands of Pikuls.

	Federated Malay States.			Straits & Unfederated States.			Net Imports F.M.S. and S.S.	Values of Column 7.
	Imports.	Exports.	Balance.	Imports.	Exports.	Balance.		
1910 ..	2,636	289	2,347	10,401	8,641	1,760	4,107	$14,779,000
1911 ..	2,788	272	2,516	10,441	7,997	2,444	4,960	$18,882,000
1912 ..	3,156	158	2,998	11,724	8,044	3,680	6,678	$36,302,000
1913 ..	3,431	293	3,138	12,786	9,539	3,247	6,385	$29,558,000
1914 ..	3,426	230	3,196	13 327	9,514	3,813	7,009	$28,789,000
1915 ..	3,145	239	2,906	13,572	11,178	2,394	5,300	$22,306,000
1916 ..	2,997	142	2,855	15,446	12,315	3,131	5,986	$25,507,000
1917 ..	2,872	105	2,767	17,946	12,667	5,279	8,046?	$38,110,000
1918 ..	2,301	128	2,173	13,958	10,680	3,278	5,451	$33,157,000
1919 ..	2,823	34	2,789	7,654	4,739	2,915	5,704	$63,642,000
1920 ..	2,394	199	2,195	5,538	2,742	2,796	4,991	$101,517,000
1921 ..	1,947	125	1,822	7,596	5,923	1,673	3,495	$13,911,000
1922 ..	2,097	107	1,990	9,548	6,063	3,485	5,475	$25,500,000
Average net imports ..	..	..	2,592	..	..	2,885	5,462	$34,488,000

(To be continued.)